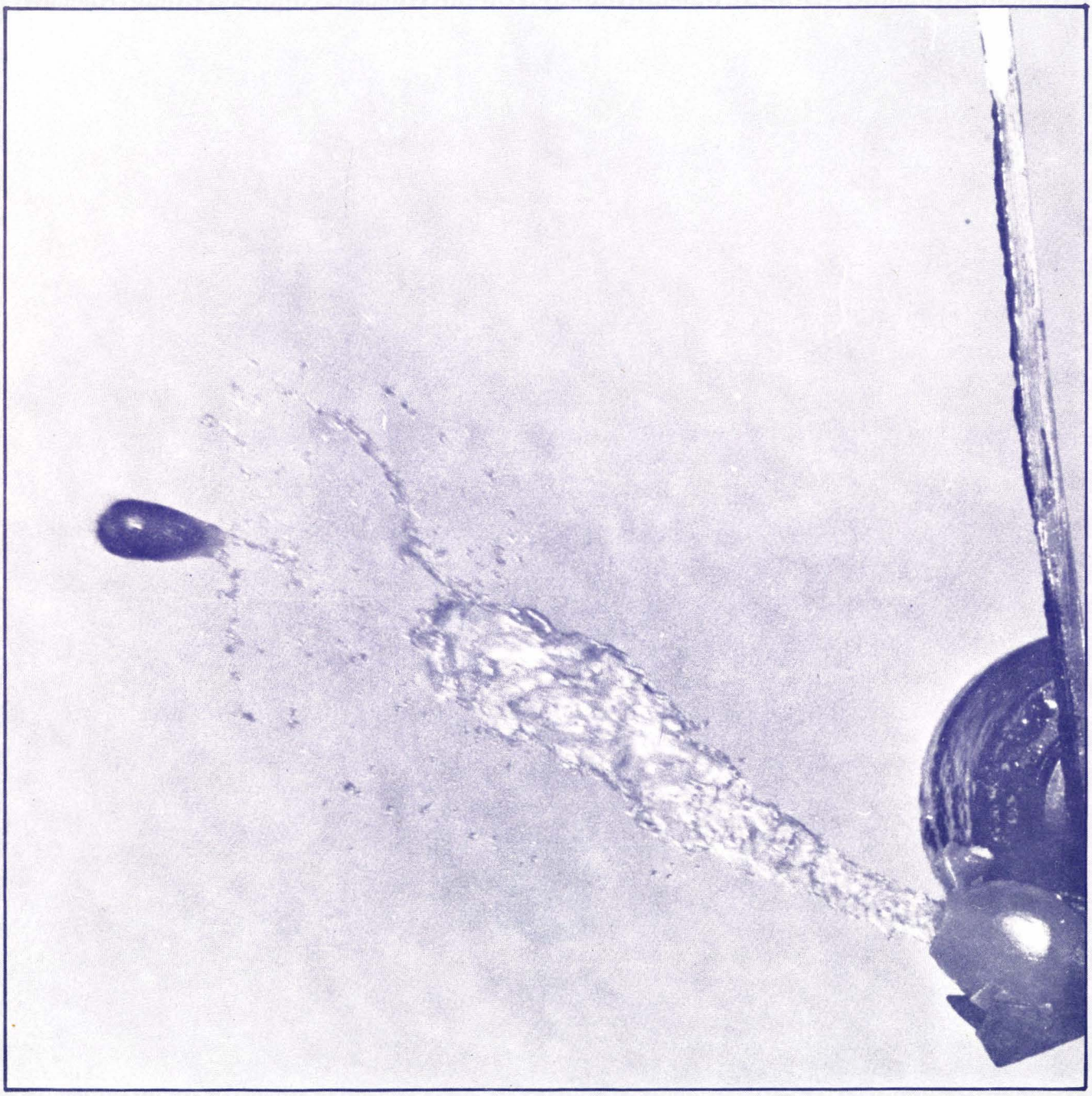
SD11
F6
88-11
c.1

United States
Department of
Agriculture
**Forest Service**

# Forestry Research West

November 1988



A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture.

# Forestry Research West

## In This Issue


| | page |
|---|---|
| Dwarf mistletoe laying siege to pines | 1 |
| Understanding vandalism helps prevent it | 7 |
| Managing to keep wilderness wild | 11 |
| New from research | 16 |


## Cover

Western dwarf mistletoe attacks conifers throughout the West. Here, a mistletoe fruit explodes, sending its seed 40 or more feet to infect surrounding trees. Researchers at the Pacific Southwest Station are focusing on this disease and the use of integrated pest management (IPM) as a control. Details begin on page 1.

## To Order Publications

Single copies of publications referred to in this magazine are available without charge from the issuing station unless another source is indicated. See page 23 for ordering cards.

Each station compiles periodic lists of new publications. To get on the mailing list, write to the director at each station.

To change address, notify the magazine as early as possible. Send mailing label from this magazine and new address. Don't forget to include your Zip Code.

Permission to reprint articles is not required, but credit should be given to the Forest Service, U.S.D.A.

Mention of commercial products is for information only. No endorsement by the U.S.D.A. is implied.

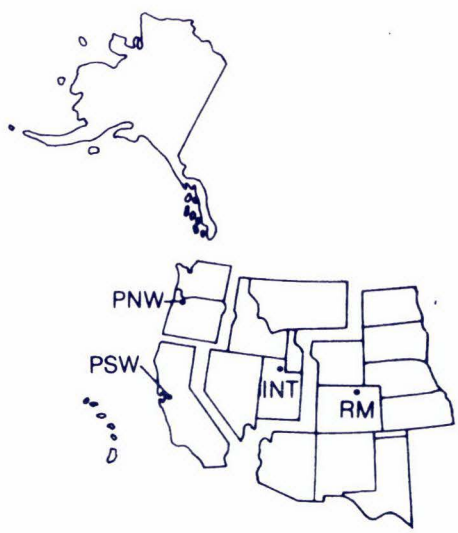
## Western Forest Experiment Stations

Pacific Northwest Research Station (PNW)
P.O. Box 3890
Portland, Oregon 97208

Pacific Southwest Research Station (PSW)
P.O. Box 245
Berkeley, California 94701

Intermountain Research Station (INT)
324 25th Street
Ogden, Utah 84401

Rocky Mountain Forest and Range Experiment Station (RM)
240 West Prospect Street
Fort Collins, Colorado 80526-2098



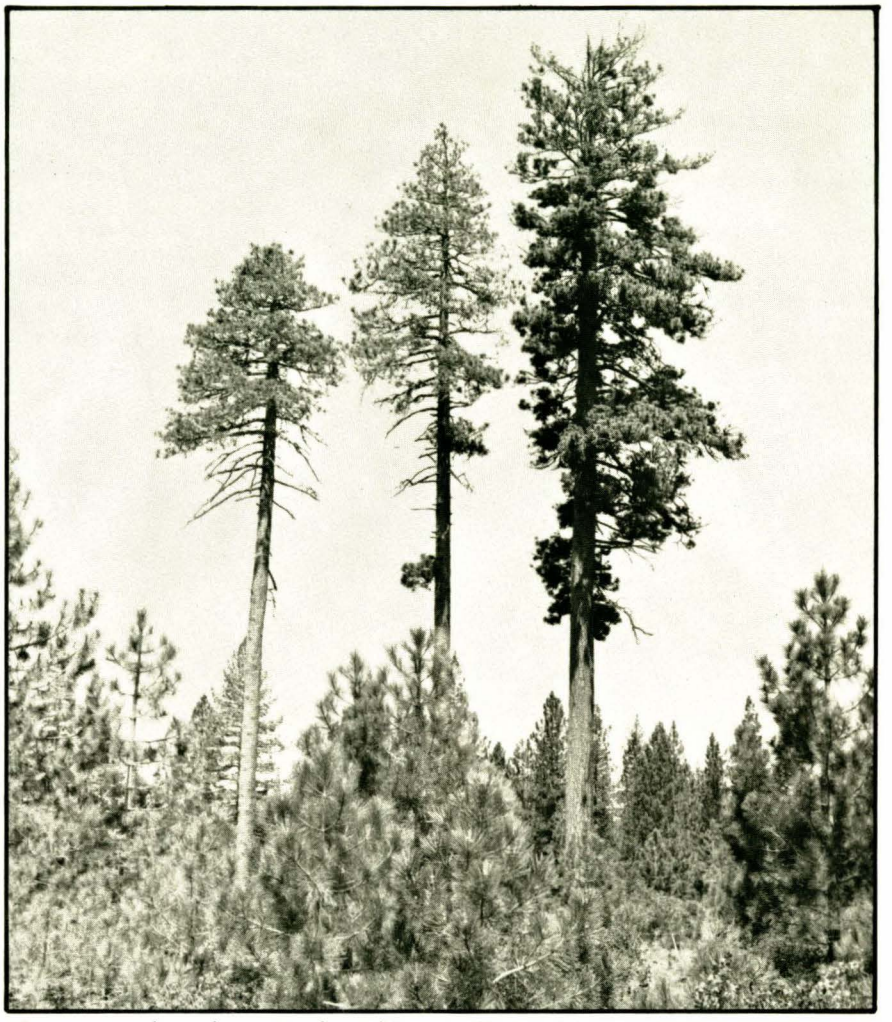
# Dwarf mistletoe laying seige to pines

by Kirsten Hempel, for
Pacific Southwest Station

Western dwarf mistletoe (*Arceuthobium campylopodum*) is a widespread and damaging parasite of ponderosa and Jeffrey pines (*Pinus ponderosa var. ponderosa*, and *Pinus jeffreyi*) in the western United States. Coulter and knobcone pines (*P. coulteri* and *P. attenuata*) are also often infected. Several other species of dwarf mistletoe occur on various other western conifers.

The damages involved are considerable both to timber areas and to high value campsites, according to Dr. Robert F. Scharpf. Scharpf, a research plant pathologist, studies dwarf mistletoe for the Pacific Southwest Station, headquartered in Berkeley, California.

He notes that victims of dwarf mistletoe produce poor timber; the quality of the wood decreases with the severity of the infection because of the numerous large knots, deformed trunks and abnormally grained, spongy wood. This softer wood is more vulnerable, and is more frequently attacked by opportunistic fungi and insects that often enter the trunk cankers obligingly opened by *A. campylopodum*. In addition, trees that are infected with this parasite are unthrifty, weak, and far less able to cope with the occasional droughts that are an integral part of California's weather. In trees supporting this demanding freeloader, timber quality and growth rates are reduced, and the mortality rate is increased from stresses such as insects, drought, air pollution and heavy recreational use. "Mistletoe is a primary invader," said Dr. Scharpf, "and it opens the way for many secondary insects and diseases."



*Abundant, large brooms caused by dwarf mistletoe in heavily infected Jeffrey pines, in California.*



LIBRARY COPY
ROCKY MTN. FOREST & RANGE
EXPERIMENT STATION

Campgrounds can be affected in several ways by dwarf mistletoe. Although *A. campylopodum* can sometimes create a tree of knarled, picturesque beauty, the final outcome may be lethal. Large "witches' brooms" (distorted branches) sap the tree's vigor and create a hazard to hikers and campers in heavily used areas. For example, mature Jeffrey pines can reach 50 meters in height. Infected broomed branches falling from only a fraction of that height can cause serious injury to an unsuspecting person below. In addition, healthy pines are part of the ambiance that draws people to the National Forests. Diseased, cankered, and dying trees not only pose an actual danger, but detract from the aesthetic value of the forest.

## A life-cycle that ensures success

Like the better-known leafy mistletoes, *Arceuthobium* species are obligate parasites, depending entirely on their hosts for protection, nourishment and reproduction. They penetrate the pine with a primary root, or radicle. Since this is seldom possible on trees that are older or have thicker bark, younger trees and the growing portions of older trees are particularly vulnerable to infection. Although dwarf mistletoe cannot penetrate wood tissue, its thread-like "cortical strands" branch and spread in the bark. There they penetrate to the inner bark (phloem and cambium), where they tap into the xylem. Eventually, lateral "sinkers" become passively embedded by the wood growing around them. They send out buds which grow to aerial shoots to begin the reproductive cycle.

*Arceuthobium* species spread their seeds with an explosion, which results from the buildup of hydraulic pressure in their fruit. The force of the explosion can hurl the seeds a horizontal distance of 30 to 40 feet, and mistletoe plants placed higher in the host tree can gain an even wider dispersal. Seeds can also leapfrog to a high branch in the same tree, moving up into the life-giving crown, increasing the severity of the infection for the host. In a stand with trees of many sizes, such a seed-dispersal mechanism is fiendishly adaptive, allowing the seeds to rain down on trees of lesser height to almost-certain food sources. Fortunately, however, birds, insects and other animals have not been shown to contribute significantly to the spread of western dwarf mistletoe. Seed dispersal takes place in the autumn, with seeds sticking to pine branches via the seeds' thick, mucilaginous coating. They usually germinate the following Spring.

Seeds germinate and readily infect twigs from 1 to 3 years of age and can, thus, gain a foothold in the crowns of trees of any diameter from seedling to large saw timber. The infection progresses slowly, taking about 5 to 6 years per plant from germination to seed dispersal. In stands anywhere near sources of western dwarf mistletoe, the chances are appallingly in favor of the mistletoe that a pine 80 to 100 years of age—big enough to use for timber—will become infected.

Symptoms of infection include visible dwarf mistletoe plants on the tree and swellings on the twigs and branches where the parasite's shoots are attached. Both witches' brooms, and highly flammable, pitchsoaked trunk cankers are signs of advanced infection. As the infection progresses, the trees look less vigorous and have less foliage except for the brooms. Badly infected stands contain broomed, deformed, stunted, dying and dead trees.

According to Scharpf, "It's not going to eliminate any species, but it will reduce tree longevity, lower seed production, reduce growth rate, cause trunk and branch deformations (lowering the quality of lumber obtainable from these trees), and cause those massive witches' brooms, which are hazardous to people and property in high use areas.

*A female (L) and male (R) plant of dwarf mistletoe on a ponderosa pine branch.*

Thus weakened, the host tree is more susceptible to opportunistic feeders such as western pine beetles (*Dendroctonus brevicomis*), Jeffrey pine beetles (*D. jeffreyi*), red turpentine beetles (*D. valens*) and California flatheaded borers (*Melanophila californica*). A study was carried out from 1973-81 by Scharpf and Detlev R. Vogler (plant pathologist for the USDA Forest Service in California) in 5 campgrounds in California and Nevada. Their results showed that insects contributed significantly to the demise of over 200 trees infected with dwarf mistletoe. Bark beetles, for example, centered their attacks on severely infected pines. According to Dr. Scharpf, this lends support to the theory of Dr. Frank Hawksworth (research plant pathologist, Rocky Mountain Station, Ft. Collins, CO) that bark beetle outbreaks can gain a foothold in infected pines, subsequently spreading to healthy trees.

## Helping trees live with dwarf mistletoe

From both a financial and ecological standpoint, living with some dwarf mistletoe is a more reasonable goal than trying to completely eliminate it, since not all of the trees infected with it are accessible or display symptoms of disease. Dr. Scharpf and his colleagues advocate a method of control called integrated pest management (IPM). IPM combines horticultural, silvicultural and newly researched ways of keeping dwarf mistletoe in check. The needs of both timber lands and high quality campgrounds can be addressed by this versatile method of control by selecting the most appropriate from the growing arsenal of weapons against this parasite. For example, with managers continuing to keep high value campsites free of dwarf mistletoe "brooms", IPM buys time for researchers to investigate known resistance to dwarf mistletoe, and any other promising methods of control.

Dr. Scharpf points out that the chemical ethephon has been shown to slow the spread of dwarf mistletoe on pines in the Rocky Mountains, but it has not been registered for use in California (Reader's note: The next issue of *Forestry Research West* will feature the use of ethephon for limiting the spread of dwarf mistletoe in recreational or other high-value forests). Biological control options are still not operational. Presently, IPM is the most effective tool available to forest managers to combat this pest. Through IPM, managers

focus on keeping the trees as healthy as possible by using both silvicultural and horticultural methods, and incorporating new work on chemical control and resistance as quickly as it becomes available. If they were to focus exclusively on eradication of dwarf mistletoe, their efforts would be fruitless if, meanwhile, host trees were suffering from loss of vigor and poor health for other reasons.

In timber producing stands, silvicultural methods such as harvesting, thinning, pruning, and species-selection have helped both in reducing spread and damage, and increasing tree vigor. But in high-value campgrounds, a different approach is needed.

In managing campgrounds, foresters can help maintain the vigor of infected trees in a number of ways. They may elect to use thinning, broom pruning, weed control, irrigation, fertilization, and/or careful regulation of human impacts to foster healthy trees and discourage dwarf mistletoe. They may install buffer strips, either of meadow grass or non-host trees around lightly infected stands; or they may carefully remove highly infected individuals where they stand above uninfected, younger trees.

*Germinated seed of dwarf mistletoe on callus tissue of Jeffrey Pine to test for resistance.*

The major goals here are (1) to prolong the lives of the trees, (2) to protect the recreational value inherent in their healthy vigor, and (3) to reduce or prevent hazard to the user. Managers can accomplish these goals both by directly reducing the amount of *Arceuthobium campylopodum* on the trees, and by coaxing the host back into the state of robust health that reduces the chances of its falling victim to secondary invaders. A combination of methods has had a synergistic effect, which proves the value of IPM.

## Research into natural resistance

"One avenue of control we have not pursued enough is resistance," said Dr. Scharpf, when interviewed in his Berkeley office. "We need to explore and capitalize on pines' natural resistance to dwarf mistletoe."

To investigate this naturally occurring resistance, Dr. Scharpf is taking both investigative and practical steps.

"First, we locate what we consider to be resistant candidates in the field. Then we collect seed and grow trees from these resistant 'mother trees.' These seedlings are then artifically inoculated and outplanted in the field, where natural infection can occur. Because this approach to resistance takes years," Scharpf explains, "we are looking for ways to shorten the process."

"Growing pines in tissue culture is one way we are trying to speed up the tests of resistance," he says. "Pine callus that can be grown in a few months on special growth media can be inoculated with dwarf mistletoe seeds and observed for tissue dying or any resistance reaction."

Although the mechanism of resistance is not yet clear, Scharpf has propagated a number of resistant Jeffrey pines from the Tahoe National Forest. He has grafted buds from these resistant trees into one foot tall Jeffrey pines in a greenhouse. This genetically pure stock will be used in tests to probe even more deeply into the reasons why some trees are more resistant than others. Meanwhile, he continues to work toward growing tissue from the resistant trees.

In support of the direction of his present research, Dr. Scharpf describes an observation by him and Dr. J.R. Parmeter (of the University of California) from their work at the Forest Service's Institute of Forest Genetics in Placerville, California. Jeffrey pine trees from several seed sources that were randomly planted in an experimental plantation in 1940, became infected by dwarf mistletoe. Twenty one years after the trees were planted, the Jeffrey pines from a Placer County seed source were much less severely infected than others.

Using an infection rating system, Dr. Scharpf tabulated the number of trees from four seed sources (Alpine, El Dorado, and Placer Counties in California, and Ormsby County in Nevada), and the degree of infection by *A. campylopodum* from 1961 to 1982 in the trees from each seed source. The mean infection rating in 1982 proved to be five times greater for the Ormsby trees than the Placer trees, although they were still considered lightly infected by dwarf mistletoe. The other two seed sources were even worse off, with infection-ratings ranging from moderate for the Eldorado trees, to very heavy for the Alpine source in 1982. The Placer seed source proved to be consistently resistant; fewer of them were infected than any other seed source, and the number of infections per tree remained very low.

*Inoculation of Jeffrey pines to test for resistance to dwarf mistletoe.*

In the future, explains Dr. Scharpf, "our geneticists will use biotechnology methods on the resistant pines to search for a long-term solution, examining the DNA and looking for enzymes or other markers that indicate resistance." Research will also be conducted with Dr. Lew Roth (retired forest pathologist from Oregon State University) on resistance of ponderosa pine.

## Mistletoe begins a struggle too many trees lose

Results from the study done by Detlev R. Vogler and Dr. Schrapf on non-resistant trees illustrate the difference that lack of resistance can make in the life of the forest. For 8 years, the two investigators collected data from five forested campgrounds in California and along the Nevada shore of Lake Tahoe, gathering information on infection intensity and tree vigor. They compared annual mortality to mistletoe infection class, radial growth, and age at death. Overall, they found that 7 percent (206) of the pines died of natural causes on all five plots. The more severe the infection, the greater the proportion of trees that were killed.

By the end of the survey, 3 percent of the uninfected, 4 percent of the slightly infected, 7 percent of the moderately infected, and an alarming 22 percent of the severely infected pines had died. They noted that cambium-feeding insects were involved in all but one of the deaths. In addition, more than 80 percent of the casualties were younger than 100 years of age, and were slow-growing (i.e. their 10-year radial growth was less than 10 mm). For a tree that normally lives up to 500 years, that is an unacceptably high rate of mortality.

## What's to be done?

Having co-evolved with their hosts, dwarf mistletoes are often impossible to completely eradicate. IPM is a more workable alternative, according to Dr. Scharpf, because it combines many different ways of combatting dwarf mistletoe. Using IPM allows managers to set up a program for mistletoe control that will fit the unique needs of their particular areas, whether timberlands or campgrounds. Since this pest interacts with insects, other diseases, climate, and the species of tree inhabiting a given section of forest, the dwarf mistletoe problem can only be effectively controlled by taking all of these factors into acount.

Through conscientious integrated pest management, both timber areas and high value campsites can have trees that are relatively healthy and safe for users. Research, currently in the midst of discoveries in resistance that will be invaluable to forest managers, promises to ease the plight of trees attacked by dwarf mistletoe. When new work on resistant strains of Jeffrey and ponderosa pine can pinpoint the causes of resistance to dwarf mistletoe, forest managers will be able to add another powerful weapon to their armory against tree disease.

For further information on this subject, readers may contact the Pacific Southwest Research Station in Berkeley, CA, and request General Technical Report PSW-103, *Management of Western Dwarf Mistletoe in Ponderosa and Jeffrey Pines in Forest Recreation Areas.*

# Understanding vandalism helps prevent it

by Cynthia Miner
Pacific Northwest Station

*Chain-like figures in pictograph before graffiti .*

*Pictograph after graffiti . (Photo credit— Mike McIntyre, Angeles National Forest.)*

"As the water was lowered by drought, Indian artifacts became visible—and artifact hunters came to hunt," described Chris Christensen, social scientist with the Pacific Northwest Station in Seattle. "Because their invasion disturbed the pelican population which was nesting, we not only lost the artifacts but also lost a prime pelican nesting site."

Christensen is familiar with the concerns of the managers affected by such incidents. Since 1978, she has focused on the many forms of vandalism. She looks at the characteristics of vandalism and the motives of the vandals for clues on how to control and prevent vandalism of recreational and cultural resources in the Pacific Northwest, the Southwest, Alaska, and, recently, in the Central States.

"I would guess that the artifact hunters were not aware of the damage potential before they went into the site," Christensen said. "This is why we need to find effective appeals through outdoor ethics to make people aware of the sometimes unintended consequences of their actions. Many people think they have a right to collect artifacts—this is an ethic that needs to be changed."

## Vandalism—a cloudy term but clearly a problem

"The term vandalism may cloud the issue," Christensen says. "The term evokes opinion, emotionalism, bias. In our work, we are beginning to define impacts in specific terms, such as table carving, looting spearheads, and destoying historic cabins. When the term vandalism is used, the listener isn't sure exactly what the speaker is referring to—is it littering, poaching, arson, or damage to vehicles at trailheads?"

In April 1988, the great variety of destructive actions included in the umbrella-term vandalism was made apparent by the wide spectrum of interests represented by attendees at the International Symposium on Vandalism: Research, Prevention, and Social Policy, held in Seattle. The 250 attendees included park, forest, city, and railroad managers; archaeologists; sociologists; psychologists; law-enforcement experts; and environmental architects whose discussions ranged from polluting the oceans to breaking into cars at trailheads. The symposium reconfirmed the need to study vandalism. "Before the symposium," explained Co-chairperson Christensen, "we had heard vandalism was no longer a major issue. From the symposium, we learned there is considerable concern by managers."

## Research: understanding the problem

Managers with vandalism problems, Christensen advises, should ask: Who is doing the damage and why? Are current strategies working to stop or reduce vandalism? If not, why not? Strategies managers use to prevent vandalism include frequent maintenance, repairing damage as soon as possible, and designing vandal-proof facilities and resources. Graffiti writers often enjoy the challenge of getting to a space to write on: the higher and more unconventional the space is, the better—from their viewpoint. The manager can make a writing space less desirable by planting vegetation in front of it, for example.

With the help of concepts and findings from research, managers can initiate, shape, or continue with greater confidence their methods to control vandalism. Christensen has worked with other researchers on a variety of studies designed to answer questions for resource managers dealing with vandalism.

## Vandalism at trailheads

In a recent study, Christensen, along with the Laurence Istvan and Grant Sharpe from the University of Washington, asked, "What characteristics of trailheads might predict the likelihood of vandalism." They questioned managers (with the Forest Service, National Park Service, Bureau of Land Management, and Army Corps of Engineers in California, Oregon, Washington, and Alaska) who indicated that heavy and inconsistent use of trailheads is associated with both vandalism of facilities and vehicle break-ins. Isolation, accessibility, and public awareness of trailheads were strong indicators for vehicle break-ins but not for facilities damage.

## Graffiti

To understand the motives and values of graffiti writers and gain insight in how to control graffiti, Christensen, with Devon Brewer and Mark Miller from the University of Washington, studied graffiti writers in the Seattle area. "We found graffiti writers place great value on the power writing gives them, the artistic expression writing and painting potentially gives them, and the fame derived from these acts. But rebellion also plays a role—and behaving against the conventional order is important. What is important for managers," Christensen said, "is that graffiti writers take their values wherever they go. The values are not confined to neighborhoods and downtowns of urban areas.

We need to relate to the writer that a preserve or forest is a different environment; it is a special place."

In another graffiti study in western Washington, Christensen and Diane Samdahl, from the University of Illinois in Urbana-Champaign, found more new carvings on wood picnic tables with previous carvings than on tables with no previous carving. They also found that campgrounds with more visible authority had less carving. Thus the recreational environment gives cues to appropriate behavior in a particular setting.

## Appeals for help in preventing litter

What happens when managers tell users about a problem in a campground and ask them to report suspicious activity they observe and to leave their own campsites clean? Christensen and Roger Clark, social scientist, Pacific Northwest Station, found that 83 percent of campers, when appealed to for help, reacted positively—picked up litter, intervened with litterers, or reported littering to a ranger—when they saw someone litter. Without any appeal for help, 61 percent of campers reacted to littering; 17 percent fewer people who heard the appeal littered, compared to people who were not applealed to. Research has shown that a systems approach—including education, litterbags and cans, incentives, and public involvement make litter control possible.

## New areas for research

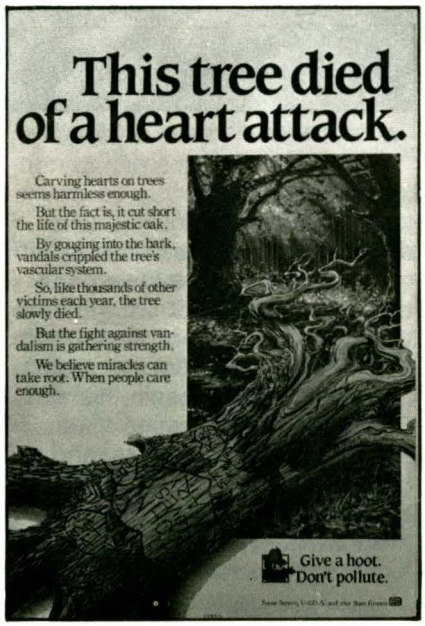
While Christensen continues work with vandalism at trailheads and broad issues of vandalism such as why some agencies experience problems with vandalism and others do not, two new priorities for her research are protecting cultural resources and developing outdoor ethics. She will look at these topics nationwide.

Cultural Resources—"Many prehistoric and historic sites throughout the country are being damaged," Christensen said, "and managers want to know what works to mitigate these impacts. We need to develop a framework which will predict what sites are vulnerable to destruction and looting and how to manage and protect the sites." Information needs include: which sites are vulnerable to destruction and looting, what are the value differences between managers and users toward cultural resources, what are the motivations for looting and destroying, and what are the effective protection strategies. To begin this work, Christensen will examine managers' knowledge, beliefs, and behavior related to cultural resource protection and management in National Forests in California and the Pacific Northwest.

*Carving a picnic table: carved tables tend to invite more carving.*

Outdoor Ethics—"Millions of dollars are spent by agencies for messages about experiencing the outdoors, and we know very little about how effective the messages are," says Christensen. So she has begun to ask: If interpretive messages can be designed specifically to reach or influence people with different outdoor ethics, will the message be more effective?

Based on theories of how morality develops, which describe a series of stages from behaving because of punishment, to acceptance of full responsibility for one's actions, Christensen and Daniel Dustin from San Diego State University have analyzed some Forest Service messages. In the framework of outdoor ethics, appeals from Woodsy Owl to "Give a hoot—don't pollute" are likely to influence people concerned with what others think. Signs that announce a $200.00 fine for littering are most likely to influence those who fear punishment, whereas a sign explaining how certain behavior fits into the ethical realm would likely influence people at the highest stage of moral development.


This tree died of a heart attack.
Carving hearts on trees seems harmless enough.
But the fact is, it cut short the life of this majestic oak.
By gouging into the bark, vandals crippled the tree's vascular system.
So, like thousands of other victims each year, the tree slowly died.
But the fight against vandalism is gathering strength.
We believe miracles can take root. When people care enough.
Give a hoot. Don't pollute.

*These Forest Service messages likely influence audiences at two different stages of moral development.*

Vandalism means many things to many people. To a camper, it may mean an unusable table, and dampen the pleasure of getting away from the city. To a hiker who finds the car broken into at a trailhead, vandalism means loss of property and a feeling of being victimized. To a land manager, it means the frustration of spending public money for repairing and helping prevent vandalism—money that could be spent otherwise. "To the researcher," Christensen explains, "vandalism provides challenges to discover effective solutions."

If you would like more information about the research described here, contact Harriet H. Christensen, Pacific Northwest Station, Seattle Forestry Laboratory, 4043 Roosevelt Way, NE, Seattle, Washington, 98105. For information about the next international symposium on vandalism, to be held in Calgary, Alberta, Canada, in 1990, contact Ernest F. Smale, The City of Calgary Parks/Recreation, P.O. Box 2100, Postal Station M, Calgary, Alberta T2P 2M5, Canada.

# Managing to keep wilderness wild

by Elizabeth Close
Intermountain Station

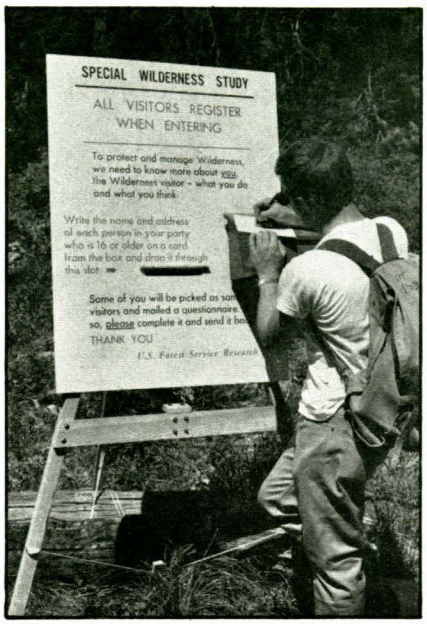
Fifteen million visitor days a year is pretty hefty recreation impact. You might expect to need a lot of picnic tables and camper pads to accommodate that much use. But instead, it all occurs in areas where development and facilities are purposefully absent—within the National Wilderness Preservation System. And managers of these areas are faced with the double whammy of wilderness recreation: how to perpetuate natural conditions and processes while providing recreational visitors with a solitary and primitive wilderness experience?

For more than 20 years the Forest Service's only research project on wilderness management has been coming up with answers to that question. The Intermountain Research Station's wilderness research unit at the Forestry Sciences Laboratory in Missoula, Montana has never been large—most of the time it has included only two scientists. Nevertheless, the unit has carried out a substantial part of all wilderness management research. It has provided continuity to the entire wilderness research effort while supporting cooperative projects by scientists at universities and other research organizations. And at the current level of three scientists and one research assistant, the program is expanding.

The unit's 20-year tenure has allowed scientists to observe changes and trends in wilderness use, and to address different parts of the recreation impact problem. Supporting the management of wilderness involves both social and ecological research.

*Multiple trails. . .*

*. . . and wet trails churned to mud by horses are two undesirable features sometimes encountered by hikers in heavily-used wilderness areas.*


SPECIAL WILDERNESS STUDY
ALL VISITORS REGISTER WHEN ENTERING
To protect and manage Wilderness, we need to know more about you, the Wilderness visitor - what you do and what you think.
Write the name and address of each person in your party who is 16 or older on a card from the box and drop it through this slot.
Some of you will be picked as sam visitors and mailed a questionnaire so, please complete it and send it ba
THANK YOU
U.S. Forest Service Researc

*This temporary registration station is an effective, low-cost way of sampling wilderness visitors.*

"We started out concentrating more on social aspects, focusing on recreation visitors, their motivations, attitudes, and knowledge levels," said Project Leader Bob Lucas. "Then in the late '70's our focus shifted to include how visitor use alters natural ecosystems as a basis for determining how such impacts may be reduced."

## An answer to the carrying capacity problem

For many years, it was commonly assumed most wilderness problems stemmed from overuse, and that establishing an area's recreational carrying capacity to limit use would solve the problem. Studies concentrated on how to set the number of visitors an area could endure, and how that number impacted the resource as well as affected the wilderness experience of other visitors. Survey research with wilderness visitors provided empirical information about how visitors perceived their wilderness experience. Scientists found that solitude is important to most visitors but not all, and that wilderness recreationists vary in their standards for what is acceptable contact with other visitors.

"Most people expected some trail encounters, but wanted to camp out of sight and sound of others," said Lucas. "While most visitors reported that meeting two or three other groups a day along the trail was acceptable, how visitors perceived others they met made a difference—were they kindred souls, or barbarians invading a holy place? We realized the impact problem was more than just total numbers of folks."

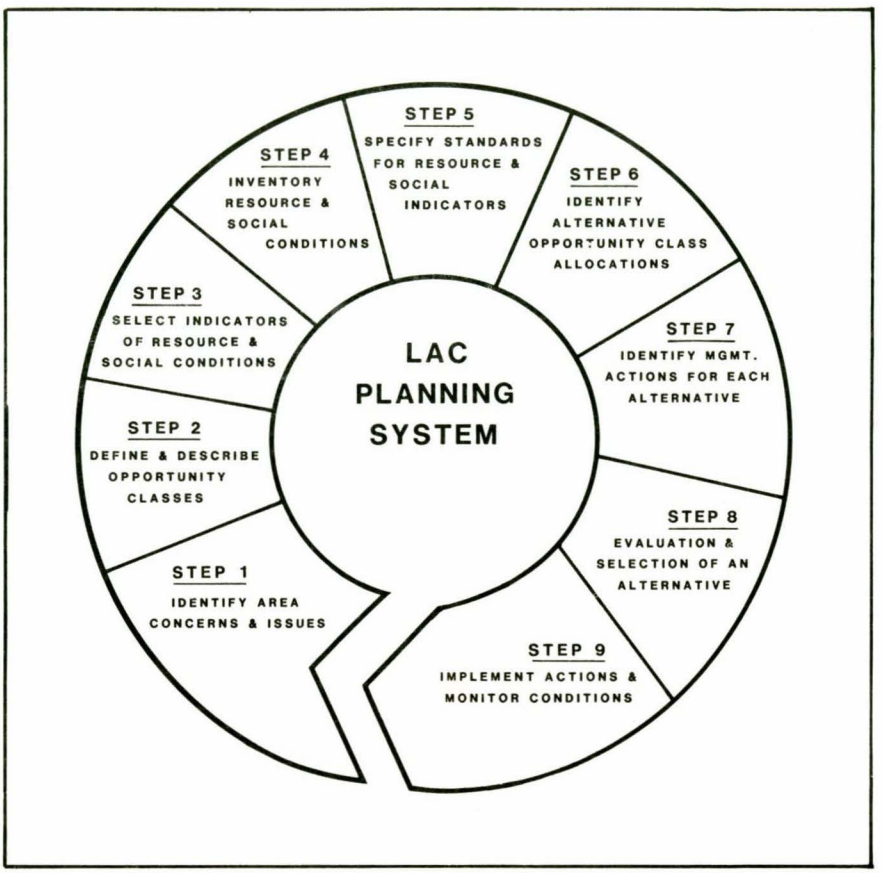
Research on visitor impacts to the environment also pointed out problems with the overuse assumption. Studies of the impacts on soils and vegetation at trails and campsites showed that most types of wear and tear were not closely related to amount of use. The effect of use varied between durable and fragile environments and locations, among different types of visitor use, and was tied closely to human behavior and camping skill.

## The needs of wilderness

"Our work with carrying capacity made it increasingly clear that the amount of use was not the only cause of wilderness degradation, and was often not the most important one. We had a lot of good information, but the wrong handle on the problem. The question was not, 'How much use is too much?', but 'What kinds of conditions should be protected as essential to wilderness?' As soon as we focused on the needs of wilderness, the way to go was obvious."

The way to go was the Limits of Acceptable Change (LAC) approach to wilderness recreation planning and management. LAC involves selecting indicators of important wilderness qualities (such as natural wildlife populations, minimal campsite impacts, solitude), establishing a standard below which the condition of each indicator is unacceptable, and selecting management actions to avoid or correct specific unacceptable conditions. Instead of relying just on limiting use, managers might deal with a particular problem by modifying the type of use, its timing, location, or certain visitor behavior. And instead of treating a wilderness as one management unit, LAC can involve setting up subunit opportunity classes where different wilderness conditions are provided, thereby increasing the diversity of the area, and providing extra protection for highly pristine sections.

"LAC provides a strong, organizing framework that accommodates a variety of conditions, setting standards that define desirable conditions in each part of a wilderness. Through monitoring, managers can discover where conditions are falling below the standard, identify what behavior caused the problem, and take specific corrective action," Lucas said.




*The Limits of Acceptable Change (LAC) system was developed in response to the need of managers for a means of coping with increasing recreational demands in a visible, logical fashion.*

Intermountain State General Technical Report INT-176, *The Limits of Acceptable Change (LAC) System for Wilderness Planning*, describes the nine steps in the LAC process and uses a hypothetical case example to show how it can lead to an effective management program. And another Intermountain Station publication, *Managing Wilderness Recreation Use: Common Problems and Potential Solutions*, General Technical Report INT-230, offers alternative strategies and tactics that help managers decide how to correct problems, once the condition of an area falls to a substandard level.

*Experiments to measure the effects of trampling on vegetation help predict the consequences of various levels of use.*

"LAC makes sense. It isn't a new idea, but is the latest step in a continuing effort to improve management through definition of more explicit, measurable objectives. LAC integrates what we've learned so far in wilderness research, and develops these principles into a framework that isn't hopelessly vague like some plans in the past," said Lucas. "I just wish we'd picked a different name. Limits of Acceptable Change almost sounds like you decide to sacrifice the quality of some areas to hang onto others, which absolutely isn't true."

"How about calling it, Thresholds of Tolerance?" suggested Lloyd Reesman, recreation staff officer on the Flathead National Forest. Reesman was recently involved in using the LAC process to develop the recreation management direction for the Bob Marshall Wilderness Complex. The success of that experience and his long tenure in wilderness management make Reesman a strong supporter of LAC.

"With LAC, we pay attention to treating wilderness like a resource, not like a recreation area," Reesman said. "The process is flexible, and we adapted it to our needs with the Bob Marshall plan. Without LAC we would still have come up with a plan, but would have really struggled with citizen participation. And the final product would not have allowed the accountability that we now see in the area's management."

## LAC in the Bob

For the Bob Marshall Wilderness Complex (BMWC) direction, an LAC Task Force with managerial, research and citizen components was assembled. Citizens included individuals from the Wilderness Society, Sierra Club and other interest groups, outfitters and recreation associations, and community groups and unaffiliated wilderness users. Discussions at task force meetings and other sessions blended the personal knowledge of all members with the collective scientific/technical knowledge of the group. Within the LAC framework, the task force concentrated on what conditions should exist in the wilderness, developing objectives and indicators that further defined the desirable state. They defined what should and can be achieved to maintain or enhance current conditions, what the future conditon of the BMWC should be, and what management actions should be taken to achieve that desirable future. The final report describes what resulted as, "an agreed to plan of action that is scientiically, politically, and administratively justified, supportable, and defensible."

"We met our first obligation, which is to protect and enhance the integrity of the wilderness resource," said Reesman. "And we met it with the agreement and support of those who have a stake and interest in how the BMWC is managed."

Bob Lucas agrees that the level of involvement LAC requires is a strength of the process. "It makes managers very accountable," he said. "Once the standards are defined, it is clear where to draw the line at visitor impact. In the past there was nothing to flash a red light. But with public and key user groups involved as true partners, accountbility for management action increases tremendously."

## Educate instead of regulate

Changes in wilderness visitor behavior through management actions often involve tradeoffs—practices that limit visitor impacts sometimes reduce visitor satisfaction. But using information and education instead of restriction to direct visitor behavior is commonly thought to detract less from enjoyment. Visitor information programs have developed rapidly in recent years, but the effectiveness of alternative methods is poorly understood.

"Regulations and restrictions have their place, but they discriminate against conscientious visitors," said Research Biologist David Cole. "Managers recognize that wilderness visitor education is a long-term investment, but it's an investment they're more and more willing to make—they just need to know how, where, when and to whom to deliver the message. We're working on ways to equip users with the knowledge to adjust their behavior to what is appropriate in a given wilderness situation. Teaching the skill instead of just reciting the rule is a major challenge."

The scientists also continue to look at visitor impacts on wilderness resources. Two resources currently under study—vegetation and wildlife—differ in that one of them moves and the other doesn't. Better understanding the effects of trampling on vegetation will improve what visitors are told in messages encouraging low impact camping. And the effect of human activity on wilderness wildlife has yet to be determined.

"Since animals are mobile, they may transport their impacted state from one part of the wilderness to another, even into areas where visitors don't go," Cole said. "Wildlife might be forced from prime habitat to less desirable surroundings that jeopardize their survival. Or they might develop behavior that is anything but natural, which is contrary to the basic objective of wilderness management. We need a better understanding—we need to turn the same attention we've given to trails and campsites, to the elk herd, songbirds and other animal and fish populations."

Research Social Scientist Alan Watson is investigating the requirements of the wilderness management job itself. Surveying wilderness rangers, forest administrators, and others, Watson is developing an exhaustive list of what these special area managers do. In the process he is uncovering the complexity of skills needed by those we expect to provide a wilderness experience.

"From noxious weed control, to working with packers and outfitters, to overseeing fire programs, wilderness management involves a tremendous variety of tasks," Watson said, "and we currently have no standards by which to judge the quality of the wilderness management job. But with a list of tasks and some acceptable standards for performance, we'll have a better understanding of the skills, background and training needed for this multi-functional responsibility."

A complete list of the wilderness research project's publications is available from: Wilderness Management Work Unit, Intermountain Research Station, Forestry Sciences Laboratory, P.O. Box 8089, Missoula, MT 59807.

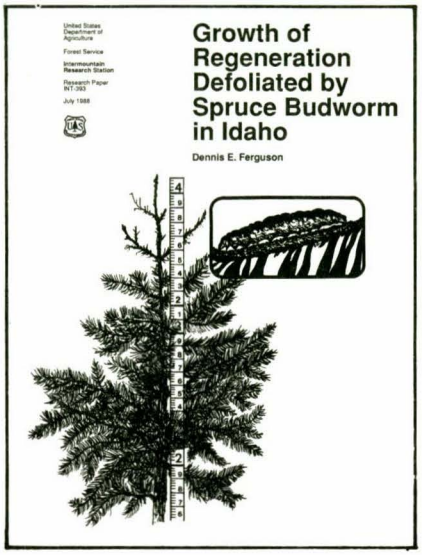
# New from research

## Management of California's hardwoods topic of symposium

Interest and concern about hardwoods in California has been increasing dramatically. A recent symposium, held at San Luis Obispo, California, addressed the State's hardwood resources and included sessions on silviculture, protection and damage factors, urban forestry-recreation, wildlife, wood products-utilization, inventory measurements, range, and policy and regulation. Use and value of the hardwood resource will continue to grow as the population increases, the resource diminishes, and new uses for hardwoods develop.

This 460+ page proceedings includes the contents of over 70 papers and 10 posters presented at the well-attended meeting.

Copies of this publication, General Technical Report PSW-100, are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161. Ask for publication number PB-88-205-505, at a cost of $38.95 plus $3.00 postage.



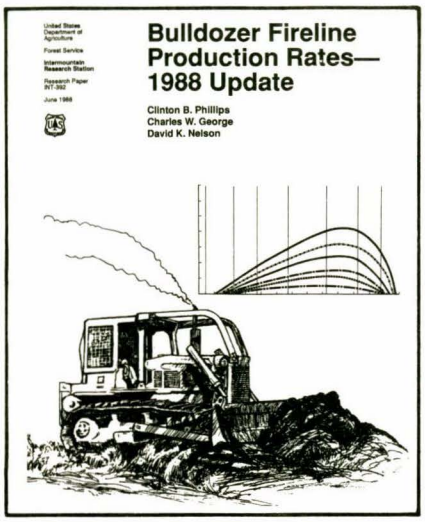

## Budworm chews on little trees too

The impact of western spruce budworm defoliation on large trees has been studied in some detail. Regeneration is also fed upon, but fewer studies have reported effects of this budworm activity. The differences in impact can be significant. Small trees have a greater proportion of current-year foliage than large trees, can have small crown ratios if growing as understory trees, and may receive a disproportionate amount of budworm dispersing from overstory trees. Understory regeneration is often defoliated sooner than larger trees. Conversely, regeneration growing in young, even-aged stands, without nearby overstory trees, is minimally fed upon by budworms.

A recent Intermountain Research Station study addressed budworm effects on four major features of regeneration development—dieback, height growth, crown ratio, and mortality. Backdating was used to characterize trees at the start of the study, then trees were measured annually for five consecutive years. Equations for predicting growth and development of four conifer species defoliated by western spruce budworm in Idaho were developed. Combinations of regeneration systems, ecological conditions, and defoliation levels were sampled to ensure that equations have broad applicability. A modeling stragegy was also developed, linking these equations to the Budworm Prognosis Model or other growth and yield simulation models.

For a copy of the final report, request *Growth of Regeneration Defoliated by Spruce Budworm in Idaho*, General Technical Report INT-393.

# Updating bulldozer production rates




They're huge and expensive and can cut a wide swath through fragile ecosystems. But because of their unbeaten effectiveness, in many situations bulldozers are still the machine of choice for constructing a fireline down to mineral soil. It is important for fire managers to have some means of estimating the rate at which various sizes of bulldozers can build firelines in different fire behavior fuel models and slope classes. Handbooks and reports currently available show bulldozer production rates that are revisions of studies made in the late 1950's and late 1960's. Not only are the production rates in those handbooks and reports outdated, they also present illogical combinations of fire behavior fuel models, and they do not differentiate major differences in production rates for upslope and downslope operation.

*Bulldozer Fireline Production Rates—1988 Update*, Intermountain Research Station General Technical Report 392, presents production rates for bulldozers manufactured since 1965, and especially for those manufactured since 1975. Rates estimated in 1984 were verified in the field, measuring the production rates for bulldozers as they constructed firelines around prescribed fires. This report presents a revised table of production rates based on the results of the field tests. It gives a range of production rates for three size-classes of bulldozers, a more logical set of combinations of the 13 fire behavior fuel models and four slope classes (both upslope and downslope), and specifies rules for selecting proper rates from the tables for different sets of field conditions.

# 50 years of research compiled

The summer of 1987 marked the 50th anniversary of the Fraser Experimental Forest (Colorado)—a cornerstone for timber, water, and wildlife research in the Central Rockies. In conjunction with this anniversary, a technical conference was held to summarize the knowledge gathered over these 50 years.

Proceedings from this gathering have now been published. Forty-three papers are presented that describe the status of knowledge about the interactions among wildlife, timber, and water. They describe a balance of perspectives between knowledge gained, and how that knowledge is actually being applied by forest managers and other resource specialists.

Write to the Rocky Mountain Station for your copy of *Management of Subalpine Forests: Building on 50 Years of Research*, General Technical Report RM-149.

## A general guide for managing P-J

More than 47 million acres in the western United States are covered by pinyon-juniper woodlands. These lands are a valuable renewable resource for many uses: livestock grazing, fuelwood harvesting, pinyon nut gathering, wildlife habitat, and a source for poles, posts, Christmas trees, and other products. Such uses have made the pinyon-juniper woodlands an important part of the West's history, as well as a resource with often-unrealized future potential.

Past use and misuse of these woodlands have left many areas degraded. Land management agencies have recently realized the need for better management of these areas. At the Pinyon-Juniper Conference held in 1986 at Reno, NV, scientists from universities and government agencies presented reports forming a comprehensive array of knowledge addressing the wise management of the pinyon-juniper type. The proceedings of that conference and many other sources served as a basis for a new Intermountain Research Station publication, *Management of Pinyon-Juniper Woodlands*, General Technical Report INT-249. The report gives managers and natural resource students general knowledge, emphasizing principles by which they can more fully understand and better manage the pinyon-juniper woodlands. The report includes appendices listing plants, animals, and birds common to the woodlands, characteristics of juniper and pinyon species, information on soils, volume and growth, and revegetation species, as well as a section of relevant and comprehensive references.

*Management of Pinyon-Juniper Woodlands* will be used as resource material for several upcoming, pinyon and juniper practitioners' workshops, being held to provide managers and specialists with an intensive update on the art and science of pinyon-juniper management.

## South Dakota's timber resources

Anything to do with South Dakota's forests probably has to do with ponderosa pine in the Black Hills, and the Black Hills National Forest contains more of it than any other area. That's the condensed overview of forests in South Dakota found in a new Intermountain Research Station forest survey report. The report presents basic information on South Dakota's forest area, volume, growth, mortality, and removals. This information was derived from inventory data collected by Forest Service research survey crews in 1979 and 1983, and from the latest data available from the Black Hills and Custer National Forests.

For a copy, request Intermountain Research Station Resource Bulletin 56, *South Dakota's Timber Resources*.

# Publication marks 25th anniversary of forest fire laboratory

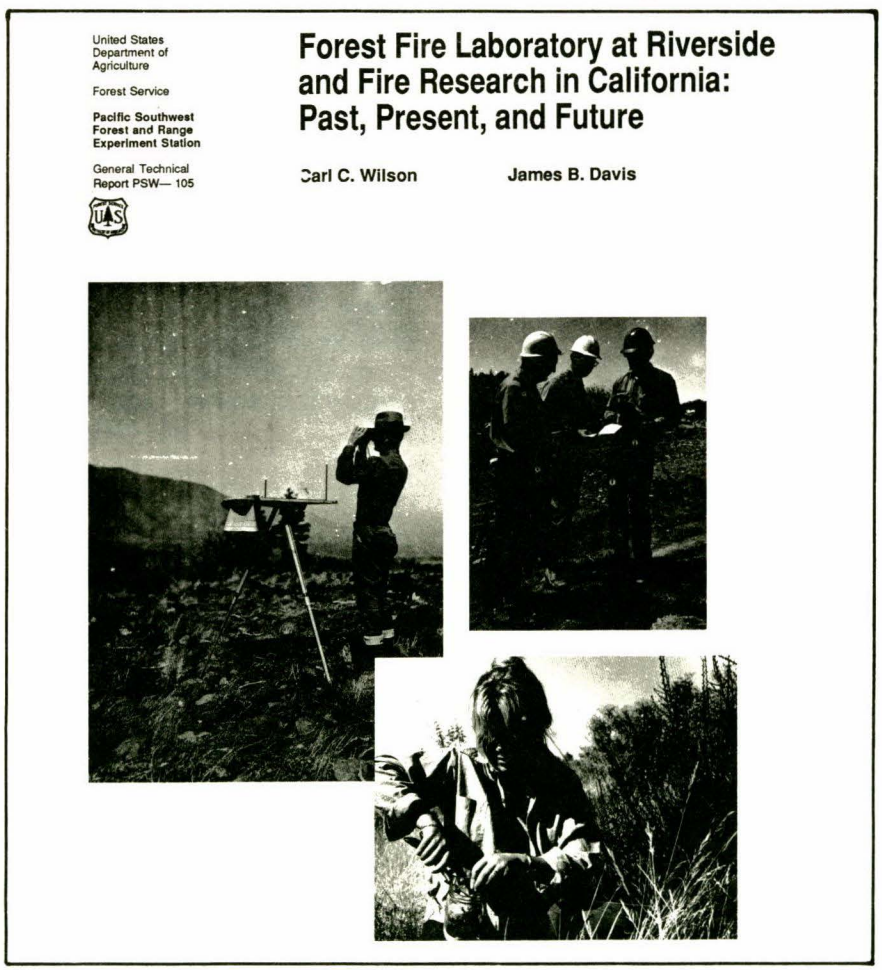
The Pacific Southwest Research Station recently issued General Technical Report PSW-105, *Forest Fire Laboratory at Riverside and Fire Research in California: Past, Present, and Future*, to commemorate the silver anniversary of the laboratory

The publication points out that the need for protection from uncontrolled fire in California was identified by the Chairman of the State Board of Forestry more than 75 years before the construction of the Riverside Forest Fire Laboratory.

With the organization of the USDA Forest Service, the need for an effective fire protection organization became apparent. In response, a somewhat fragmented research program got under way in the 1910's. Although the research was successful in reducing fire damage under most conditions, severe fire years still made it clear that a strong cohesive fire research effort, headquartered at an adequate laboratory, was necessary. However, the Fire Laboratory did not "just happen." It was the result of considerable organized public and private support.

During the 50 years before the dedication of the Laboratory, and the 25 years since, there has been an effort to balance a pragmatic approach toward dealing directly with the fire manager, and also maintaining scientific excellence. The publication highlights past accomplishments from the Lab, and describes the work of the six research projects currently operating at the Laboratory, units focusing on fire management and the beneficial use of fire, forest recreation, effects of air pollution on forest ecosystems, and watershed management.

Contact the Pacific Southwest Station to receive copies of this publication.


United States Department of Agriculture
Forest Service
Pacific Southwest Forest and Range Experiment Station
General Technical Report PSW— 105
Forest Fire Laboratory at Riverside and Fire Research in California: Past, Present, and Future
Carl C. Wilson
James B. Davis

## A physical exam for wilderness ecosystems

A new Rocky Mountain Station report is helping land managers and other resource specialists determine the physical, chemical, and biological condition of wilderness resources.

The paper presents a number of scientific protocols to measure current conditions of air quality related values (AQRVs) in wilderness areas which are designated Class I under the Clean Air Act. These protocols are intended to be guidelines for quantifying the existing status of AQRVs, monitoring for changes in these existing conditions, and subsequently evaluating whether the changes are naturally occurring, or the result of man-caused air pollution/chemical deposition.

The scientists and contributors that produced this paper focused on four areas: atmospheric environment, soils and geology, aquatic chemistry and biology, and vegetation.

These protocols will help all land managers of Class I areas meet the mandates of the Clean Air Act.

Details are available in *Guidelines for Measuring the Physical, Chemical, and Biological Condition of Wilderness Ecosystems*, General Technical Report RM-146, available from the Rocky Mountain Station.

## Using point counts to monitor bird populations

Three basic methods—spot mapping, transects, and point counts—have been developed to estimate numbers of birds. A research note recently published by the Pacific Southwest Research Station focuses on point counts, the method best suited for monitoring on a large scale.

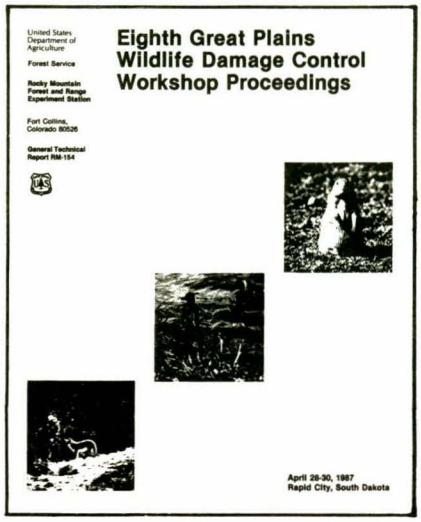
Minute-by-minute analysis of point counts of birds in mixed-conifer forests in the Sierra National Forest in central California, showed that cumulative counts of species and individuals increased in a curvilinear fashion but did not reach asymptotes after 10 minutes of counting. Comparison of the expected number of individuals counted per hour with various combinations of counting time and noncounting times (for record keeping and travel between counting stations) showed that 10-minute counts were most efficient in most cases. Counting longer than 10 minutes is not recommended because of the increased risk of double counting some individuals.

To receive this publication, contact the Pacific Southwest Station and request Research Note PSW-395, *Optimizing the Duration of Point Counts for Monitoring Trends in Bird Populations*.

# Wildlife damage control proceedings available

The Eighth Great Plains Wildlife Damage Control Workshop was held in Rapid City, South Dakota, last Spring. Over 200 wildlife specialists, land managers, administrators, researchers, educators, and others convened to further technology and information transfer. Fifty-six papers were presented and have now been published by the Rocky Mountain Station. They cover damage caused by prairie dogs and related small mammals, by waterfowl, and by other wildlife such as coyotes, cougars, and beavers. In addition to information on mechanical and chemical control methods, ecosystem processes are also covered.

Request *Eighth Great Plains Wildlife Damage Control Workshop Proceedings*, General Technical Report RM-154.


United States Department of Agriculture
Forest Service
Rocky Mountain Forest and Range Experiment Station
Fort Collins, Colorado 80526
General Technical Report RM-154
Eighth Great Plains Wildlife Damage Control Workshop Proceedings
April 28-30, 1987
Rapid City, South Dakota

# Reprint of a PNW classic

A widely used reference, *Natural Vegetation of Oregon and Washington*, by Jerry F. Franklin and C.T. Dyrness, has been reprinted with a supplement of more than 500 bibliographic entries current through 1987. First published in 1973 and unavailable since 1981, this book serves as a source for land managers, scientists, and students.

The volume describes and explains the vegetational zones of the region, including composition and succession of each zone, and their environmental relations. Unusual habitats, physiography, geology, and soils are also discussed. The appendices define soil types, list scientific and common names of plants, and provide a general subject list. Over 200 photographs illustrate the book.

The 8 x 10½-inch paperpack book can be bought for $22.95, plus $2.00 for postage and handling, from the Oregon State University Press, 101 Waldo Hall, Corvallis, OR 97331. Those who already have copies of the original book may request the supplement from the Pacific Northwest Research Station.

# Symposium focuses on wildland fire management in 2000 AD

A 258-page publication issued last fall by the Pacific Southwest Research Station documents almost 50 presentations made at the *Symposium on Wildland Fire 2000*, held from April 27-30, 1987, at South Lake Tahoe, California.

This "futuring" symposium addressed the possible, preferred, and probable status of wildland fire management and research in the year 2000 and beyond. Papers cover the fire protection needs of the public, management response to these perceived needs, and the research and education required to meet these needs. Also covered in a separate section are the interactions between forest user, manager, and researcher, as well as international issues. Nine papers, developed by the futuring process and presented at the symposium, examine key trends, define preferred "visions" of fire management in the year 2000, and describe strategies to achieve these visions.

One paper describes how the Incident Command System (ICS), which is popular among fire service agencies, was used to organize and conduct the symposium.

Copies of this publication General Technical Report PSW-101, are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161. Request PB-88-199-666; at a cost of $25.95, plus $3.00 for postage.

# 50 years of research

The San Dimas Experimental Forest is a field laboratory for studies in the ecology of chaparral and related ecosystems. Research has been underway here for over 50 years, so its broad data base and unique physical features make San Dimas an ideal location for a broad range of studies. It serves as a "Biosphere Preserve" under the United Nations' Man and the Biosphere Program, giving international recognition to its values.

The Pacific Southwest Research Station recently issued a publication describing the physical features of the Experimental Forest and the research history of the Forest over the past 50 years. Appendices include listings of the flora, mosses, and vertebrate fauna found within the boundaries of the Experimental Forest. An extensive reference list is also included.

Interested readers may obtain copies by contacting the Pacific Southwest Station and requesting General Technical Report PSW-104, *The San Dimas Experimental Forest: 50 Years of Research*.

To order any of the publications listed in this issue of *Forestry Research West*, use the order cards below. All cards require postage. Please remember to use your Zip Code on the return address.

Please send the following Pacific Northwest Station publications:

- ☐ *Natural Vegetation of Oregon and Washington*, (supplement ONLY).
- ☐ Other _____

Send to: _____

_____

_____

Please send the following Rocky Mountain Station publications:

- ☐ *Guidelines for Measuring the Physical, Chemical, and Biological Condition of Wilderness Ecosystems*, General Technical Report RM-146.
- ☐ *Management of Subalpine Forests: Building on 50 Years of Research*, General Technical Report RM-149.
- ☐ *Eighth Great Plains Wildlife Damage Control Workshop Proceedings* General Technical Report RM-154.
- ☐ Other _____

Send to: _____

_____

_____

Please send the following Intermountain Station publications:

- ☐ *The Limits of Acceptable Change (LAC) System for Wilderness Planning*, General Technical Report INT-176.
- ☐ *Managing Wilderness Recreation Use: Common Problems and Potential Solutions*, General Technical Report INT-230.
- ☐ *Growth of Regeneration Defoliated by Spruce Budworm in Idaho*, General Technical Report INT-393.
- ☐ *Bulldozer Fireline Timber Production Rates—1988 Update*, General Technical Report INT-392.
- ☐ *South Dakota's Timber Resources*, Resource Bulletin INT-56.
- ☐ *Management of Pinyon-Juniper Woodlands*, General Technical Report INT-249.
- ☐ *Proceedings—Future Forests of the Mountain West: A Stand Culture Symposium*, General Technical Report INT-243.
- ☐ Other _____

Send to: _____

_____

_____

Please send the following Pacific Southwest Station publications:

- ☐ *Management of Western Dwarf Mistletoe in Ponderosa and Jeffrey Pines in Forest Recreation Areas*, General Technical Report PSW-103.
- ☐ *Forest Fire Laboratory at Riverside and Fire Research in California: Past, Present, and Future*, General Technical Report PSW-105.
- ☐ *Optimizing the Duration of Point Counts for Monitoring Trends in Bird Populations*, Research Note PSW-395.
- ☐ *The San Dimas Experimental Forest: 50 Years of Research*, General Technical Report PSW-104.
- ☐ Other _____

Send to: _____

_____

_____

STAMP

Rocky Mountain Forest and Range Experiment Station
240 West Prospect Street
Fort Collins, Colorado 80526-2098

(Attn: Publications Distribution)

STAMP

Pacific Northwest Research Station
P.O. Box 3890
Portland, Oregon 97208

(Attn: Publications Distribution)

STAMP

Pacific Southwest Research Station
P.O. Box 245
Berkeley, California 94701

(Attn: Publications Distribution)

STAMP

Intermountain Research Station
324 25th Street
Ogden, Utah 84401

(Attn: Publications Distribution)

# Future forests of the Mountain West

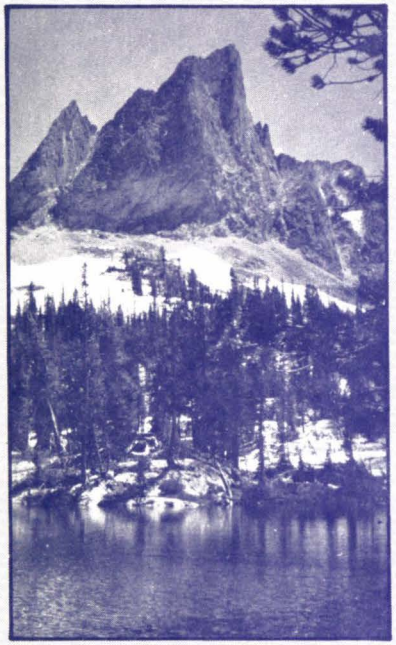
Old-growth forests in the West, which produced many of the resources needed in the past century, are gradually being reduced by fire, insects, disease, and harvesting, and are being replaced by young forests with potentials that are only now beginning to be realized. These young forests make up an increasingly more common scene on the slopes of the inland mountains, and provide tremendous challenges and opportunities that were not feasible in the old-growth stands. Because of the predominance and attendant problems of old, mature forests, early western forest research and management concentrated largely on developing the knowledge and techniques needed to properly harvest and regenerate trees. Young forests presented a whole new set of knowledge gaps that resulted in the redirection and gradual shifting of research and management emphasis into efforts that featured young forests. This knowledge has been accumulating in various publications and unpublished reports, but much of it has not been readily available to resource managers.

"Future Forests of the Mountain West"—a catchy sounding title that was coined to attract natural resource people to "A Stand Culture Symposium"—did just that. More than 300 people came to hear 57 papers and see 24 posters that presented the most current technical information about young forests of the Mountain West. The goal of the symposium was to form "a legacy of quality forests for future generations." The depth, breadth, and quality of the papers in the proceedings demonstrates the tremendous strides that have been made in these few decades toward the development of knowledge and the management of young forests.

For a copy of the proceedings, request Intermountain Research Station General Technical Report 243, *Proceedings—Future Forests of the Mountain West: A Stand Culture Symposium*.

**FORESTRY RESEARCH WEST**
U.S. Department of Agriculture
Forest Service
240 West Prospect Street
Fort Collins, Colorado 80526

*Official Business*
*Penalty for Private Use, $300*



**BULK RATE**
**POSTAGE & FEES PAID**
**USDA · FS**
**Permit No. G·40**